

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY


(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 27 JUN 2005

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Applicant's or agent's file reference Cal 88473		FOR FURTHER ACTION		See Form PCT/IPEA/416
International application No. PCT/EP2004/009684		International filing date (day/month/year) 31.08.2004	Priority date (day/month/year) 04.09.2003	
International Patent Classification (IPC) or national classification and IPC C08J11/08, C08J3/09				
Applicant POLIMERI EUROPA S.P.A.				
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 4 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau a total of 6 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>				
<p>4. This report contains Indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>				
Date of submission of the demand 31.03.2005		Date of completion of this report 27.06.2005		
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized Officer Hallemeesch, A Telephone No. +31 70 340-2431		



**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/009684

Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-20 as originally filed

Claims, Numbers

1-18 received on 05.04.2005 with letter of 04.04.2005

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT
ON PATENTABILITY**

International application No.
PCT/EP2004/009684

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-18
	No: Claims	
Inventive step (IS)	Yes: Claims	1-18
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-18
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

1). State of the art

Reference is made to the following documents dealing with a process for recycling expanded polystyrene by dissolving in a solvent and precipitating with a non-solvent.

D2 : solvent may be diethyl carbonate; non-solvent is a lower alcohol.

D4 : solvents are ethers or esters; non-solvent is a lower alcohol.

These differences establish novelty for independent process claim 1 (Art. 33(2) PCT).

2). Art. 33(1)(3) PCT - Inventive step

The distinguishing feature of claim 1 with regard to closest prior art D2 is that the non-solvent contains an alkylene carbonate. The technical effect is that this non-flammable compound allows a more efficacious removal of bromine compounds with respect to the use of alcohols alone (compare example 20 with example 22). The problem to be solved is to provide a process showing this effect in view of D2.

The solution of using alkylene carbonate non-solvents has not been mentioned in the state of the art, be it that in accordance with D4, the ester or ether solvents may comprise an amount of alkylene carbonate. The non-solvent, however, is an alcohol.

The skilled one will not contemplate to combine the teachings of D2 and D4, and arrive in this way to the process of claim 1.

Consequently, claim 1 is also based on an inventive step and the requirements of Art. 33(1) PCT are met.

EPO - DG 1

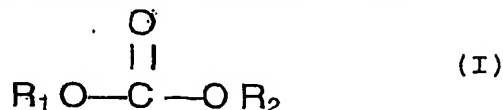
05. 04. 2005

(65)

CLAIMS

1. A process for recycling expanded polystyrene comprising:

- (a) volume reduction of expanded polystyrene by
 5 dissolution with
 a dialkyl carbonate, or a blend of dialkyl carbonates, having the general formula (I):



10 wherein R_1 and R_2 , the same or different, have the following meaning:

- R_1 , R_2 represent linear, branched or cyclic alkyl radicals, containing from 1 to 12 carbon atoms, and the sum of the carbon atoms of R_1 and R_2 is between 2
 15 and 15,

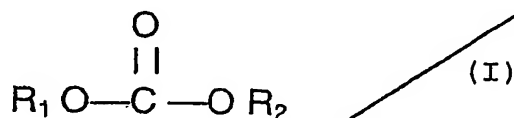
(b) removal of the insoluble components;

(c) selective precipitation of polystyrene with a non-solvent or a blend of non-solvents for polystyrene;

- 20 (d) separation, drying and extrusion of the precipitated polystyrene,
 said process being characterised in that the selective precipitation of polystyrene is carried out with a non-solvent selected from alkylene carbonate
 25 or a blend consisting of an alcohol and an alkylene carbonate.

CLAIMS

1. ~~Use of a dialkyl carbonate, or a blend of dialkyl carbonates, having the general formula (I):~~



wherein R_1 and R_2 , the same or different, have the following meaning:

- R_1 , R_2 represent linear, branched or cyclic alkyl radicals, containing from 1 to 12 carbon atoms, and the sum of the carbon atoms of R_1 and R_2 is between 2 and 15,

~~as solvents for expanded polystyrene.~~

A process

2. ~~The use of a dialkyl carbonate, or a blend of dialkyl carbonates, according to claim 1, wherein:~~

- R_1 , R_2 represent linear or branched alkyl radicals, containing from 1 to 8 carbon atoms, and the sum of the carbon atoms of R_1 and R_2 is between 5 and 10.

A process

3. ~~The use of a dialkyl carbonate, or a blend of dialkyl carbonates, according to claim 2, wherein the dialkyl carbonates are selected from those having a flash point higher than 55°C.~~

A process

4. ~~The use of dialkyl carbonate, or a blend of dialkyl carbonates, according to claim 3, wherein the dialkyl carbonates are selected from the group consisting of di-n-butyl carbonate, di-isobutyl carbonate, di-n-~~

propyl carbonate.

~~5 A process for recycling expanded polystyrene compris-
ing:~~

- ~~5 (a) volume reduction of expanded polystyrene by dis-
solution with a dialkyl carbonate, or a blend of
dialkyl carbonates having formula (I);
(b) removal of the insoluble components;
(c) selective precipitation of polystyrene with a
non-solvent or a blend of non-solvents for poly-
10 styrene;
(d) separation, drying and extrusion of the precipi-
tated polystyrene.~~

~~5 6.~~ The process for recycling expanded polystyrene accord-
ing to claim ¹~~8~~, wherein, in step (a), the concentra-
15 tion of polystyrene in the solution is between 5 and
50% weight and the dissolution of the expanded poly-
styrene with dialkyl carbonate is carried out at at-
mospheric pressure, at a temperature ranging from 20
to 70°C.

~~20 6 7.~~ The process for recycling expanded polystyrene accord-
ing to claim ⁵~~8~~, wherein the concentration of polysty-
rene in the solution ranges from 15 to 40% by weight.

~~7 8.~~ The process for recycling expanded polystyrene accord-
ing to claim ⁵~~8~~, wherein the dissolution of expanded
25 polystyrene with dialkyl carbonate is effected in an

apparatus equipped with a stirring system and at room temperature.

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8. The process for recycling expanded polystyrene according to claim ¹8, wherein the selective precipitation of polystyrene in step (c) is effected by feeding the styrene solution to the non-solvent, or blend of non-solvents, maintained under turbulent stirring, onto the bottom of the precipitation reactor, below the stirring system.

10 ~~10. The process for recycling expanded polystyrene according to claim ¹¹8, wherein the selective precipitation of polystyrene in step (c) is effected with a non-solvent, selected from the group consisting of glycols, alcohols, alkylene carbonates, dialkyl carbonates with a number of carbon atoms equal to or higher than 17, alkyl esters of fatty acids.~~

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11. The process for recycling expanded polystyrene according to claim ¹8, wherein the quantity of non-solvent, or blend of non-solvents, used for selectively precipitating the expanded polystyrene in step (c) is in a weight ratio with the dialkyl carbonate of between 2:1 and 20:1.

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12. The process for recycling expanded polystyrene according to claim ⁹11, wherein the quantity of non-solvent, or blend of non-solvents, used is in a weight ratio

with the dialkyl carbonate of between 3:1 and 15:1.

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13. The process for recycling expanded polystyrene according to claim ¹~~5~~, wherein the selective precipitation of polystyrene in step (c) is effected at a temperature ranging from 10 to 70°C.

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14. The process for recycling expanded polystyrene according to claim ¹¹~~13~~, wherein the selective precipitation is effected at a temperature ranging from 15°C to 60°C.

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15. The process for recycling expanded polystyrene according to claim ⁸~~9~~, wherein the selective precipitation of polystyrene is effected by feeding the polystyrene solution to the non-solvent onto the bottom of the precipitation reactor, with a flow rate, expressed as g/(hour*liter of non-solvent), within the range of 30-1500.

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16. The process for recycling expanded polystyrene according to claim ¹³~~15~~, wherein the solution of polystyrene is fed to the non-solvent with a flow rate, expressed as g/(hour*liter of non-solvent), within the range of 50-800.

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17. The process for recycling expanded polystyrene according to claim ¹~~8~~, wherein the separation of polystyrene precipitated in step (d) is effected by filtration, decanting, centrifugation, at a temperature ranging

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from 10°C to 70°C.

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18. The process for recycling expanded polystyrene accord-
ing to claim ¹⁵17, wherein the separation of the pre-
cipitated polystyrene is effected at a temperature
within the range of 15°C - 60°C

5 17
19. The process for recycling expanded polystyrene accord-
ing to claim ¹8, wherein the drying of the polystyrene
precipitated in step (d) is effected at a temperature
ranging from 50°C to 180°C and a pressure of between
10 760 and 1 mm Hg.

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20. The process for recycling expanded polystyrene accord-
ing to claim ¹⁷19, wherein the drying is effected at a
temperature ranging from 80°C to 150°C and a pressure
of between 500 and 10 mm Hg.

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